

# A COMPARISON BETWEEN NATURAL AND SOLAR DRYING OF BANANA CHIPS AND CHILLY DRYING USING SMOOTH AND ARTIFICIALLY ROUGHENED ABSORBER PLATE IN SOLAR AIR HEATER

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## ABSTRACT

*The present work compares natural and solar drying technique for drying banana chips and chilly drying. The solar drying method is carried out in two ways using smooth and artificially roughened absorber plate of solar air heater. The solar air heater is having dimensions 1000mm length, 540 mm width and 30 mm height. The width is divided into two equal portions, one fitted with smooth absorber plate and another with artificially roughened absorber plate. Artificial roughness in absorber plate is done by shot peening process. The natural drying process was carried out from 8:00 AM to 5:00 PM under open sunlight. Solar drying technique was used with a solar air heater fitted with smooth and artificially roughened absorber plate. The hot air from solar air heater was passed into a cabinet dryer comprising of four metal drying trays of dimension 41.5 cm \*28 cm, consisting of mesh and painted with black board paint to enhance heat absorbing capacity. It took seven days for chill to dry completely naturally. Smooth plate and roughened plate solar drying of chilli completed in four days and three and half days respectively. The maximum temperature difference of 19.2 °C and 21.2 °C was observed for chilli drying using smooth and rough plate respectively. Banana chips dried naturally almost in one day with removal of 670 gm moisture, on second day only 10 gm moisture is removed. The solar drying of banana chips completed in three hours and two hours using smooth plate and roughened plate respectively. The maximum temperature difference using smooth plate and rough plate was 15 °C and 21 °C respectively.*

*It is observed that the drying time is considerably reduced using roughened plate along with better texture of the product.*

**KEYWORDS:** Artificial Roughness, Banana Drying, Chilli Drying, Solar Air Heater & Solar Dryer

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## 1. INTRODUCTION

Solar drying is an ancient practice used by humans to preserve food. In modern time various application of heating and drying are performed using solar energy. Solar energy offers the following advantages:

- Source of energy is inexhaustible.
- Totally pollution free.

- Can be utilized for all purposes.
- Can be utilized in any form of energy.
- Scope for decentralization.
- Easy to operate
- Minimum working expenditure.
- Saves fossil fuel deposit.
- Economically self sufficient.
- Less hazardous.

### LIMITATIONS OF SOLAR ENERGY

- Problem of storage.
- Not available on cloudy days.
- Quantum varies according to season or weather.
- The initial investment is high.
- Needs subsidy.
- Spares not easily available.
- Creates problem for urban planning since higher building interrupts lower solar system.
- Not yet taken on the priority list.

Modern applications of solar energy are given in Table 1.

**Table 1 Applications of Solar Energy**

Equipment	Features/Use
Solar cookers	Economic, Easy to us
Solar air-conditioning and refrigeration	Remote/ military application
Solar water heaters	Domestic, Hotels and hospitals
Solar dryers	Agriculture/ food industry
Solar pumps	Farming
Solar furnaces	Small/ Medium size industry

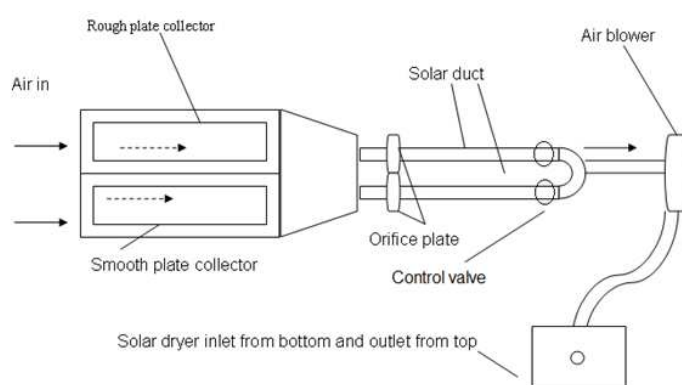
As the natural solar energy is very weak in its application the solar air heaters are used to enhance its effectiveness. To further increase the efficiency of a solar air heater the absorber plate is artificially roughened.

There are various methods for artificial roughness e.g. machining the absorber plate, providing fins on the plate, providing rib on a plate and shot peening the plate. Various methods have their own advantages and limitations.

The experimental setup comprises of

- Solar air collector
- Blower and Electric motor
- Cabinet type drier

The Solar collector has dimensions, length 151cm, width 22 cm and height 30 mm as shown in Figure 1. It has rectangular duct covered with a single glass cover and divided into two sections, one for smooth plate and another for rough plate, each one connected to an insulated circular pipe of diameter 44.44 mm and an orifice plate connected to measure flow through manometer. At the end of each pipe a control valve is fitted to control the air flow. These two pipes are then connected to a U shape pipe to connect to a single pipe fitted to blower inlet.



**Figure 1: Experimental Setup**

A cabinet type solar dryer comprises of four number of drying trays of dimensions 41.5 cm length and 28 cm width (Figure 2).



**Figure 2: Dryer and Drying Tray**

Air blower is used for forced circulation of air into the solar air heater. It is run by a 0.5 HP single phase electric motor.

### 3. DATA REDUCTION

Experimental Conditions

Dryer dimensions 28.5 cm X 45 cm X 26 cm

Drying tray dimensions 41.5 cm X 28 cm

Hydraulic Diameter 44.44 mm

### SAMPLE CALCULATION

ML=Moisture Loss

Mi=Initial mass

Mf=final mass

MC=Moisture Content =  $M_i - M_f / M_f * (1)$

M=mass of product =1 kg

T=temperature = 42 °C = 273+42 = 315 K

L=latent heat of air =315.27 kJ/kg=315270 J/kg

I<sub>c</sub>=Solar Insolation = 950 W/m<sup>2</sup>

A= Dryer area = 4\*one plate area = 4\* 41.5\*28 cm<sup>2</sup>=4\*41.5\*28\*10<sup>-4</sup> m<sup>2</sup>

t = time = 1 hour=3600 sec

Dryer efficiency (  $\eta$  ) =  $ML / I_c * A * t$

=  $(1 * 315270) * 100 / (950 * 4 * 41.5 * 28 * 10^{-4} * 3600)$

= 20.462 %

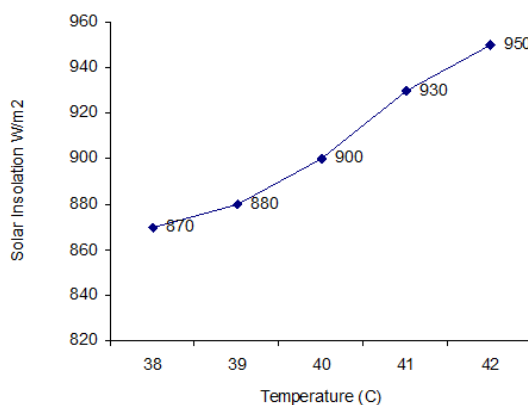


Figure 3: Relation between Temperature and Solar Radiation at Bhopal

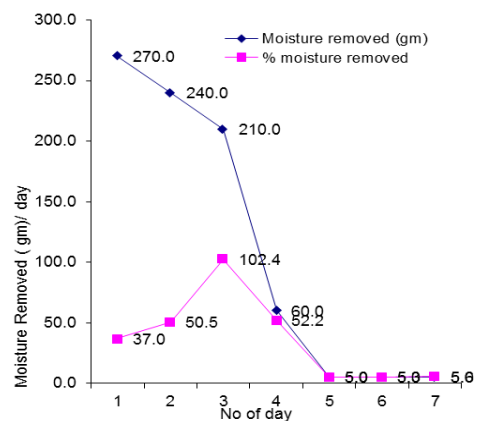
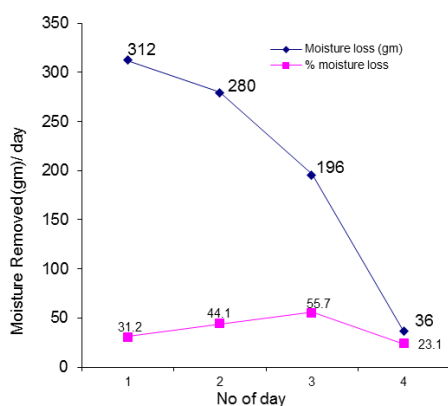
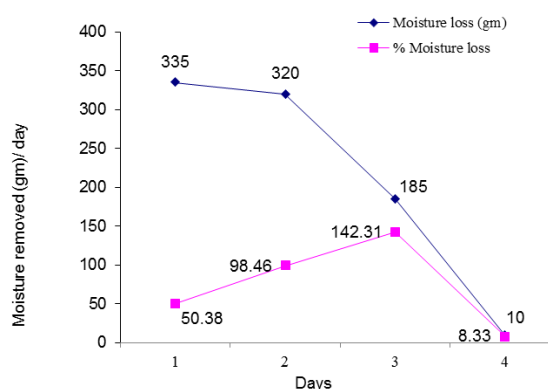


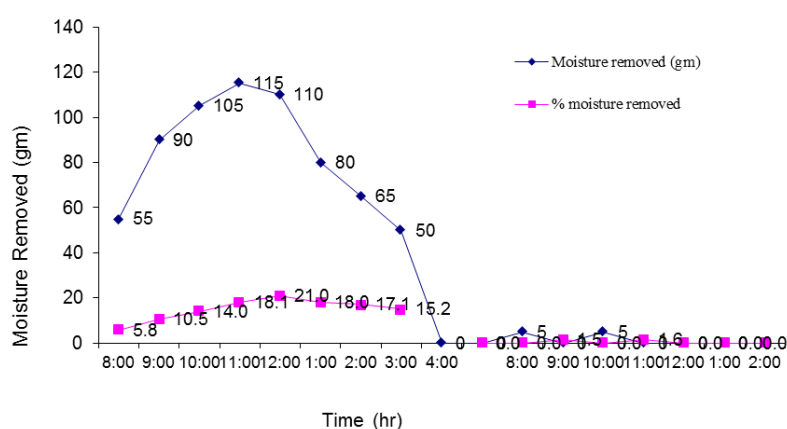
Figure 4: Natural Drying of Chilli



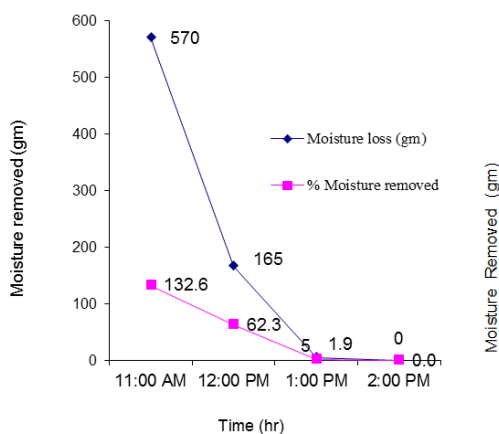
**Figure 5: Smooth Plate Chilli Drying**



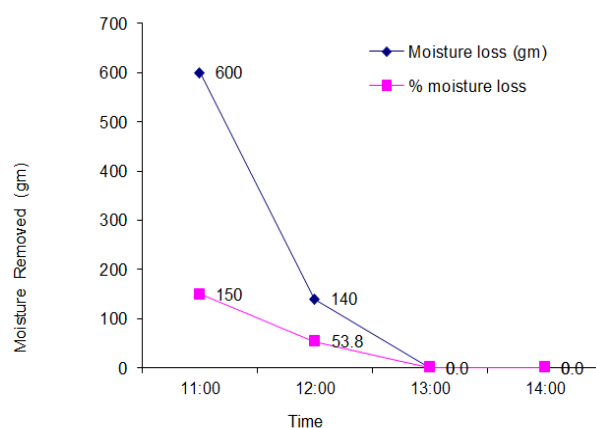
**Figure 6: Rough Plate Chilli Drying**



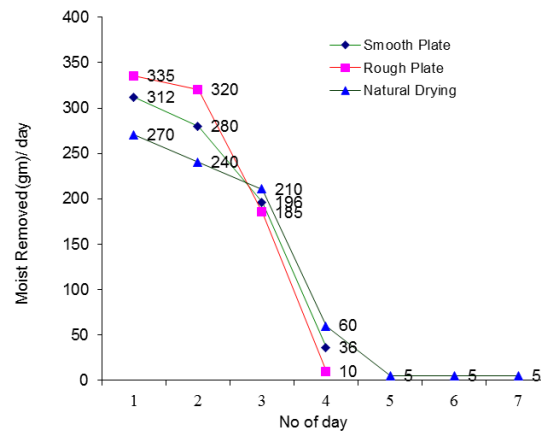
**Figure 7: Natural Banana Chips Drying**



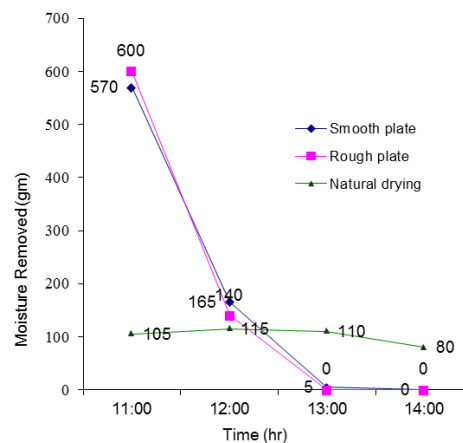
**Figure 8: Smooth Plate Banana Chips Drying**



**Figure 9: Rough Plate Banana Chips Drying**



**Figure 10: Comparison between Natural, Smooth Plate and Rough Plate Drying**



**Figure 11: Comparison between Natural, Smooth and Rough Plate Drying**

#### 4. CONCLUSIONS

- Natural drying of chilli is carried out between 8:00 AM to 4:00 PM. Chilli is completely dried in seven days. In first, second and third day 27%, 24% and 21% of initial mass is removed. By the fourth day chilli is almost dry.
- Natural drying of banana is completed in two days with 67% of initial mass is dried in the first day and it is almost dry.
- With smooth plate solar drying chilli is dried in four days. Total moisture removed in first, second and third day is 31%, 28% and 20% respectively and it is almost dry.
- With rough plate drying chilli is dried in three and a half days with 32.5%, 32% and 18.5% in first three days respectively.
- Smooth plate banana drying is completed in one day with 57% and 16.5% of initial mass removed in the first two hours.
- Rough plate banana drying is completed in two hours with 60% and 14% of initial mass is removed in first and second hour respectively.
- Solar drying produces a good texture of dried product.

- The process can be useful in mass drying for industries.

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